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RESPONSE-INDUCED IMAGERY IN CROSS-MODAL TRANSFER OF FORM DISCRIMINATION

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Molander, B., and Garvill, J. Response-induced imagery in cross-modal transfer of form discrimination. Umeå Psychological Reports No. 127, 1977. - In a cross-modal transfer experiment subjects learned to associate forms varying in imagery value with three-dimensional objects which were presented either visually or tactually. After training in one modality transfer was tested in the other modality. It was hypothesized that verbal labels facilitate tactual stimulus encoding more than visual stimulus encoding and that this facilitation is more pronounced with high-imagery labels as compared to low-imagery labels. The results showed that transfer in the tactual-visual order was superior to transfer in the visual-tactual order and that the size of this asymmetry was the same for both types of labels. These results are taken to indicate that imagery is of minor importance as a mediating process in the cross-modal transfer of form discrimination.

It has been suggested that cross-modal transfer of form discrimination is made possible through the mediation of verbalization (Ettlinger, 1967): Although several authors have provided indirect support for this hypothesis (Gaydos, 1956; Garvill & Molander, 1971; Koen, 1971) others have found that verbalization is not a necessary requisite for cross-modal transfer to occur (Blank, Altman, & Bridger, 1968; Davenport, Rogers, & Russel, 1973). Blank et al., for instance, investigated visual and tactual form discrimination in preschool children and found transfer from vision to touch. However, the children were not able to label or describe the shapes, which suggested to the authors that some nonverbal mediating mechanism was operating, and imagery seemed to be a likely candidate. The idea that imagery serves a mediating function in the transfer of information between the visual and tactual modalities has been put forward by other researchers as well (Koen, 1971; Paivio, 1971;

Walsh, 1973) but judging from a recent review of cross-modal transfer and matching (Freides, 1974) there have been no attempts to experimentally manipulate this factor.

The purpose of the present report is to investigate the role of imagery by varying the imagery values of the response terms in a cross-modal learning situation. In a series of experiments (Björkman, Garvill, & Molander, 1965; Garvill & Molander, 1968; Molander & Garvill, 1977) where three-dimensional "nonsense" objects served as stimuli and figures as responses it has consistently been shown that transfer from touch to vision is superior to transfer from vision to touch. This asymmetric transfer effect may be explained by assuming that visual as well as tactual stimuli are visually coded (e.g. images are evoked) the tactual modality demanding more trials of training before consistent stimulus representation is achieved. If this is true it should be possible to affect the stimulus encoding by using verbal labels as responses. Verbal responses which easily evoke images may conceivably facilitate tactual encoding more than visual encoding. This facilitation should be less pronounced when low imagery labels are used. In both cases it is expected that transfer in the tactual-visual direction is superior to transfer in the visual-tactual direction since tactual encoding is relatively favoured and presumably easier to take advantage of after the shift to the visual modality. However, this asymmetric transfer effect should be greater with high imagery labels as compared to low imagery labels.

It is likely that verbal labels high in meaningfulness and imagery should give facilitating effects rather than inhibiting effects. Experiments on the effects of verbal labels on the encoding of verbal stimuli and "nonsense" shapes have generally shown positive effects (Daniel & Ellis, 1972; Ellis, 1973; Ellis, Parente, & Schumate, 1974; Federico & Montague, 1975; Santa, 1975; Santa & Ranken, 1972). However, most of the experiments have been concerned with the effect of labels on recognition in intra-modal tasks. The present experiment gives an opportunity to test the generality of those findings in a cross-modal task and where transfer rather than recognition is in focus.

Method

Subjects. Sixtyfour male and female students from the university of Umeå served as subjects. 51 of those subjects were students in introductory courses in Psychology and participated in the experiment as a part of a course requirement. The others were students in other disciplines at the university and were paid for the participation. No subjects had earlier acquaintance with cross-modal experiments. During the course of the experiment 8 subjects were replaced due to failure to meet the learning criteria.

Materials. Seven ceramic "nonsense"-shaped objects were used as stimuli. These stimuli are identical in smoothness, colour, size and weight but varying in form. In the present case the objects were painted white, the height and weight being approximately 10 cm and 350 gr respectively. Each of the objects could easily be grasped by one hand although the subjects were instructed to actively use both hands in the tactual training. A drawing of one of the stimulus objects as it is presented in the experimental situation is provided elsewhere (Garvill & Molander, 1971). To each of the seven objects a noun was randomly assigned. These nouns constituted the response terms and varied in imagery value. Two sets of nouns, high-imagery and low-imagery, were selected from a Swedish scaling of the Paivio, Yuille, and Madigan (1968) nouns (Molander & Garvill, 1974). The seven high-imagery nouns were BUNGALOW (bungalow), OFFICER (officer), MIKROSKOP (microscope), BUKETT (bouquet), SÄCKPIPA (bagpipe), ÅNGBÅT (steamer), and ISBJÖRN (polar bear) with a mean imagery value of 5.68 (range 5.03 - 6.17). The low-imagery nouns were KOMPETENS (competence), TOMHET (emptiness), PÅVERKAN (influence), MIRAKEL (miracle), VÄLFÄRD (welfare), HEMVIST (abode) and SKAPARE (creator) with a mean imagery value of 2.65 (range 2.23 - 3.13). The two sets were equal in rated meaningfulness (Molander & Garvill, 1974) and in word frequency (Allén, 1971).

Design and procedure. The subjects were randomly assigned to 4 groups with 14 subjects in each. For two of the groups training started in the tactual modality whereupon transfer was tested in the visual modality (TV). The other two groups were trained and tested in the opposite order (VT). Within each modality order one group used high-imagery responses

(TV-H and VT-H) and the other group low-imagery responses (TV-L and VT-L). Thus a 2 (modality order) x 2 (high-imagery responses vs. low-imagery responses) factorial design was applied.

Before visual or tactual training started, the subjects in each group learned the responses by rote in order to minimize response learning during training. This procedure was thought to increase the similarity between the present experiment and the experiments referred to earlier (e.g. Björkman et al., 1965; Garvill & Molander, 1968; Molander & Garvill, 1977) where figures were used as responses, and where subjects could respond at the very first trial in the training and transfer phases. The responses were learned by an alternate study and recall procedure where the seven nouns were presented by the means of a tape-recorder. The subject listened to the presentation for 10 seconds whereupon he was allowed 15 seconds to recall the nouns in any order he preferred. The presentation order of the nouns was varied randomly from trial to trial and the learning proceeded until a criterion of two consecutive correct trials was met.

During tactual and visual training the subject was seated in front of a screen. When a stimulus object was presented tactually the subject put his hands under the screen and could then manipulate the object by active touch without seeing it. During visual presentation the stimulus object was placed on a rotating disc behind the screen at eye level. The disc rotated two turns during the exposure which lasted for 5 seconds. The time of the exposure was the same in visual and tactual conditions and the objects were always presented with the same "side" towards the subject in both modalities. At the end of each exposure the assigned label was presented by means of a tape recorder. In each group the subjects were divided in two subgroups, each with a different assignment of labels to objects. Since the training followed a PA-learning procedure with anticipation the subject had to respond within 5 seconds after the stimulus presentation and before feedback was given from the tape recorder. Before the start of the training phase the subject read a standard instruction where the anticipation method was explained and where it was pointed out that on the first trial he had to guess the correct labels. It was also pointed out that the subject during the training should try to put the objects in some meaningful relations to the images evoked by the

labels. This instruction to use imagery was thought to further increase the presumably facilitating effects of the labels. No information was given about the learning criterion in the training phase or that training was followed by a transfer phase in another modality. After the instruction was read a demonstration of the procedure was made by presenting the subject a stimulus-response pair which did not belong to the experimental pairs. At the end of the training in the first modality and before transfer was tested in the second modality there was a short pause (approximately 1 minute) where the apparatus was changed and where new instructions were given to the subject. He was informed that the training would go on exactly as in the first phase with the same stimuli and responses with the exception that stimuli would be presented in another modality. From the very first trial in the transfer phase the subject was supposed to give as many correct responses as possible and if he did not know the correct response he had to guess. The training in the transfer phase was carried to a criterion of two consecutive correct trials with the restriction that all subjects should perform at least 10 trials. In both the training phase and the transfer phase the interitem interval as well as the intertrial interval was 5 seconds. In order to prevent serial learning the order of stimulus presentation was varied from trial to trial.

Results

The learning of high-imagery labels and low-imagery labels by the alternate study and recall procedure was compared by applying an analysis of variance on the trials to criterion measure. This analysis revealed that there were no differences between groups learning the same type of labels but that groups learning high-imagery labels were significantly faster than groups learning low-imagery labels ($F(1.52) = 4.77, p < .05$), a result which is in accordance with earlier findings (Dukes & Bastian, 1966), and which indicates that the two sets of labels differed satisfactorily with respect to the imagery factor.

In the first training phase the number of trials to the criterion of two consecutive correct trials was calculated for all subjects. A two-way analysis of variance (type of modality vs. type of label) performed on this measure showed that visual learning was approximately twice as fast as tactual learning ($F(1.52) = 57.08, p < .01$) the combined group means being 14.2 and 30.4 respectively. No main effect of type of labels or interaction effects were found. Even if there was no effect of labels on the rate of learning within the experiment it is possible that the labels had a general facilitating or inhibiting effect. However, it was found in an earlier experiment with the same stimulus objects and the same training criterion but where figures instead of verbal labels served as responses, that the means for meeting the criterion was 12.3 and 24.4 for visual and tactual training respectively (Molander & Garvill, 1977). This comparison shows that if there is any effect of the labels whatsoever on the rate of learning, it is in the inhibiting direction.

Transfer between the modalities was measured by calculating the ratio P_1/P_k for all subjects, where P_1 is the proportion correct responses in the first trial in the transfer phase and P_k is the proportion correct responses in the last trial in the training phase. A two-way analysis of variance on this measure yielded a significant effect of modality order ($F(1.52) = 14.29, p < .01$), the TV-order being superior to the VT-order. No other effects reached significance. Means and standard deviations based on the P_1/P_k -measure is presented in Table 1, where also corresponding data from Molander and Garvill (1977) is included.

In order to test whether the magnitude of the transfer effects were significant the differences between P_1 -values and corresponding "guessing" values were calculated. Thus, in the VT-H group, for instance, the proportion correct responses in the first trial in the transfer phase was compared to the proportion correct responses in the first trial of training in the TV-H group. In all groups the differences were significant as tested by t-test ($p < .01$) and it may thus be concluded that positive transfer effects were obtained.

It has been suggested that the superiority of the TV-order simply is an effect of the higher capacity of the visual modality (Lobb, 1968). In the present case this would mean that subjects should use a more effective guessing strategy when transfer is tested visually or in the first trial in the visual training. However, an one-way analysis of variance performed on number of correct responses in the first trial in the training phase showed no differences between the modalities in this respect ($F < 1$).

Table 1. Mean proportion transfer (P_1/P_k) and standard deviations.

	Modality order					
	VT-H	TV-H	VT-L	TV-L	VT ^x	TV ^x
Mean	.48	.75	.49	.60	.66	.83
S. D	.18	.13	.22	.20	.15	.12

^xData from Molander and Garvill (1977)

Although no effects of type of labels was obtained in the present experiment, Table 1 suggests that compared to the data from Molander and Garvill (1977), the labels may have lowered the magnitude of transfer or changed the size the asymmetric effect. In order to test these possibilities the data from the two experiments was compared in a two-way analysis of variance with modality order as the first factor and type of labels as the second factor. This analysis yielded significant effects on both modality order ($F(1.54) = 27.99$, $p < .01$) and type of labels ($F(2.54) = 9.72$, $p < .01$). This latter effect was further analysed by a Newman-Keuls test which showed no differences between high-imagery labels and low-imagery labels and that figures compared to verbal labels were significantly more effective ($p < .05$). Since no interaction effect was obtained in the analysis of variance it may thus be concluded that the verbal labels did not affect the size of the asymmetry between modality orders but compared to figures as responses they have a negative effect on the magnitude of transfer.

Discussion

In agreement with a series of earlier experiments (Björkman et al., 1965; Garvill & Molander, 1967; Garvill & Molander, 1971; Molander & Garvill, 1977) the present experiment shows that in cross-modal form discrimination, visual learning is faster than tactual learning and that transfer in the tactual-visual order is superior to transfer in the visual-tactual order. However, the hypothesis that image-evoking verbal labels would differently affect visual and tactual stimulus encodings and thus change the size of the asymmetric transfer effect did not get support. Although no effects of varying the imagery values of the labels were obtained the results indicate that verbal labels as compared to figures negatively affected the rate of learning and the magnitude of the transfer effects.

A possible explanation of these results is that the meaningfulness of the labels is a more important factor than the imagery value. Since the labels were equated with respect to meaningfulness no differential effects could be obtained. This reasoning is in line with the finding that verbalization is more effective than imagery when stimuli are difficult to encode, whereas imagery is more important when stimuli are less complex and easy to encode (Federico & Montague, 1975). It also seems that the labels used in the present experiment mainly served to affect the retention and retrieval of the stimulus encodings rather than affect the selection of aspects of stimuli that would be encoded. Presumably the concrete high-imagery labels should direct the subjects attention to stimulus aspects common to the tactual and visual modalities (e.g., form) to a larger degree than abstract low-imagery labels and consequently lead to a larger transfer effect. However, such a directing function is not supported in the present case since the size of the asymmetry remained unchanged. Even if it is not to be denied that it may be possible to direct the subjects attention to common aspects via more "representative" experimenter-supplied labels or via direct instruction, several experiments within the present paradigm (Molander & Garvill, 1977) suggest that stimulus parameters and the perceptual capacities of the modalities are more important determiners of what is encoded.

The fact that the present experiment resulted in slower visual and tactual learning and less transfer than an earlier experiment where figures were used as responses is consistent with the view that verbalization occurs during the learning.

Presumably the experimenter-supplied verbal labels may interfere with subject-generated verbalizations and this interference is more pronounced with nouns than with figures. However, a more likely and simple explanation is that the figures are preexperimentally well learned and thus demand less response-learning than the nouns. The fact that there was an orderly relation between the figures (the seven objects were assigned the numbers 1-7) further increased their availability for retrieval and recall.

The present results are at variance with those obtained in experiments where random shapes have been associated with verbal labels (Daniel & Ellis, 1972; Ellis, 1973; Federico & Montague, 1975; Santa, 1975; Santa & Ranken, 1972). In these experiments it was demonstrated that verbal labels facilitate stimulus encoding and that the facilitation was more pronounced with stimuli difficult to encode. However, in the present experiment three-dimensional "nonsense" objects was used as stimuli, rather than two-dimensional random shapes. Performance was measured by recall in a new modality, rather than by recognition in the same modality. The labels varied in imagery rather than in meaningfulness and they were not selected to be "representative" of the stimuli. One or more of these factors may be responsible for the differing results.

In summary then, the present experiment replicates earlier findings that visual learning is faster than tactual learning and that transfer in the tactual-visual direction is superior to transfer in the visual-tactual direction. Furthermore, the fact that a variation of the imagery values of the response terms did not affect the size of the asymmetric effect indicates that imagery is of minor importance as a mediating process in the cross-modal transfer of form discrimination. The results suggest that verbalization rather than imagery may serve such a function.

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